Part I

Overview: Looking Around

The chapters to follow introduce what we shall be looking for as this book unfolds, and they also introduce the worlds of policy making, planning, system deployment, and management. The emphasis is on actors and institutions, as well as the process at work. There is a cross-section view—how things are today. Subsequent parts of the book address why things are as they are.

When describing how things are we emphasize the United States and its federal government. Readers are challenged to look around their neighborhood for similarities at international, local government, and agency levels. Similarities are there, just under different names.

We shall begin looking back in part II, where we will tell the railroad story, and in part III we shall look back and around while visiting the other modes. Part IV will consider the interaction of transportation and complementary experiences, those that form the inputs to transportation. Part V will ask how innovation and other actions aid in creating experiences, and in part VI we ask the reader to engage in speculations about the present and the future.
Chapter 1

Introduction

We still . . . [ask students in college] . . . to think, but we seldom tell them what thinking means; we seldom tell them it’s just putting this and that together; it’s just saying one thing in terms of another. To tell them to set their feet on the first rung of a ladder the top of which sticks through the sky.
—Robert Frost, Education by Poetry

The Transportation Experience explores the genesis of transportation systems; the roles that policy plays as systems are planned, innovated, deployed, and reach maturity; and how policies might be improved. While the territory to traverse is vast, underlying themes that characterize policy development and implementation facilitate our journey. In a sense, policy matters are simple. They just seem complex because policy games are played on diverse stages, with many actors, and with issues that appear under different names. Policy themes have much in common across modes, from time to time, and from situation to situation. Their complexity is more apparent than real.

The first concentration of the book will be on policy. Planning enters when it is triggered by policy decisions. Moreover, planning experiences may inform policy, though this seems infrequent. Our third focus emerges as much policy aims to aid deployment and to respond to problems encountered as systems grow. Finally, management issues manifest as modes mature.

A neat sequence of policy followed by planning, deployment, and operations? The sequence gives a nice but incorrect image of an orderly step-by-step unfolding of processes. It is misleading because things may happen out of sequence and often in parallel—for instance, deployment may begin with policy racing to catch up. In addition, the forces of experience and tradition hold across the board, so to speak. So when we say, for instance, “X affected planning” or “Y affected policy,” the reader should have in mind “and other things.” It is not a neat world with compartmentalized causes and effects.

Emphasis is on the American and British experiences since the beginning of the industrial revolution. The reader will find, however, that the American or British experiences are hardly unique. They have roots in Western Europe, and each country is but
one stage for the playing out of themes common to all places. And while much of the transportation system in Europe and North America is mature (if not senescent), the rest of the world is still planning, developing, and deploying. The accomplishments and mistakes of the more developed countries generate lessons that may be applied to places where networks remain nascent or adolescent.

To begin at an arbitrary point in time and place leaves unanswered the question of how experiences before that point in time shaped beginnings. Sometimes Western Europe is considered the locus for the emergence of what we call “the modern world.” We know that there were beginnings, or the resources for beginnings, in many places. China, in particular, demonstrated the capability to organize knowledge, resources, and technologies for large-scale public works and transportation activities. It developed navigation instruments, defense walls, great canals, roads, and bridges. In the fourteenth century, China was a major maritime power, using large ships and considerable organizational capability. China imposed its will in Southeast Asia and as far away as Africa. The advantages to be had from transportation and trade were there. Additionally, the development of knowledge was well advanced in China compared to Europe. Yet in the following centuries, Europe came to dominate technology and progress.

However, it is unclear to what extent precursor experiences in and outside of Europe affected the developments that were born in Western Europe. Ideas are light baggage, and through contacts during the Crusades and through travel and trade, Western Europe might well have borrowed ideas.

**Quest**

There are a number of ways of organizing the text. It could be based modally, telling the story of each mode in turn. Building on Bruno (1993), it could be a giant timeline, giving the history of transportation from when humans first walked on two legs to the present. It could use the “life cycle” paradigm of birth, growth, maturity, and senility, and describe the modes in parallel (but out of chronological sequence) by this paradigm. It could order by “structure,” considering infrastructure, equipment, and operations as our basic organizing scheme. It could distinguish between urban, rural, and intercity transportation, and passenger and freight transportation, giving us a $3 \times 2$ matrix. It could distinguish between nodes (ports, airports, terminals, intersections) and links (roads, rails). It could be organized by “supply chain,” considering inputs, process, and outputs. We have selected a hybrid, organized thematically (figure 1.1).

In spite of our emphasis on themes, generic topics, or theory, the book begins with an overview of current and recent policy activities. The taxonomy enables us to obtain a first-cut answer to the question “What is it we wish to explain?”

The text then tackles planning themes, beginning with the emergence of transportation planning as a discipline from a variety of sources, not simply the urban transportation planning that is today most widely known. The topics of deployment and the life cycle of technologies are addressed. This is followed by the issues of management of mature systems.

We then turn to the search for the systematic ideas that thread policy debates and policy-making activities. We review the development of the railroads and the policies bearing on their birth and deployment. An important finding emerges quickly. It will be
seen that the railroads borrowed or learned from previous experiences, especially road and canal building and operations. To aid in seeing the influence of precursor experiences, the relations between rail and road and canal experiences will be traced. With only minor modifications, railroads elsewhere copied the precursor experiences embedded in English railroads. Policies for roads and canals were augmented and revised to enable railroad construction and operations.

As deployment proceeded, the railroads developed policies to cope with problems and to aid in grasping opportunities. Some of these policies were embedded in rail institutions; some were imposed by government; and some were developed jointly. The discussion will examine the pattern of embedded versus government policies in some detail because much policy in later modes borrowed from the rail experience. That is especially true for rail transit.

In addition to illustrating the policy development pattern, the railroad discussion will illustrate a paradigm for the analysis of a system as it is born and deployed, and later, as maintenance of service and market shares become central matters. As is true of policy, system structure and behavior tend to be frozen by early events and the embedded policies developed to aid deployment.

The pattern is not a simple one, however. This is because a system’s behavior and performance are a function of structure, the system’s life-stage and changes in its environment, including the development of competitive modes.

The overview of policy, planning, deployment, and management activities constitute the first part of the book. The search for systematics using the railroad life cycle is the second part of the book. The third part of the text will examine the situation in other modes. Extended discussions will be given to the maritime and inland waterway modes, for they challenge readers to apply knowledge to situations they may not know well. Readers may be more familiar with the highway, transit, and air situations.

The fourth part of the book cuts across modes and looks at complementary experiences that might be considered “inputs and outcomes.” We examine some of the things
necessary to produce transportation (communications, energy, money, information, time, land), as well as the outcomes of transportation (environmental effects—which can be transformed, for instance, by saying that clean air is an input).

The fifth part of the book examines creating experiences, innovation, technology, imagination, and measuring the real benefits transportation provides. In this part we move beyond examining what is and consider what might have been and what might be. This permits thinking outside the existing modes and operating strategies, to consider alternative paths of development. The text concludes with key points and speculations.

These discussions will counter some conventional wisdom. Most think of each mode as having a unique history and status, and each is regarded as the private playground of experts and agencies holding unique knowledge. However, we argue that while modes have an appearance of uniqueness, patterns repeat and repeat: system policies, structures, and behaviors are a generic design on varying modal cloth. The illusion of uniqueness will prove no more than myopic.

As our discussion proceeds, themes such as these will emerge:

- Policies are built from experiences. At the dawn of a system, experiences are mainly transferred from other, older modes.
- Policies mirror the intrinsic characteristics of systems and the interplay of those characteristics with deployment problems. This theme overlaps with the previous theme. The words “intrinsic characteristics” refer to the structure, behavior, and performance of systems, and this theme notes that these characteristics affect policy.
- Policies may be strictly embedded in system organizations and protocols or, at another extreme, in governments. The question of appropriate loci and shared power is long-standing, and it has mainly been answered on pragmatic grounds.

There are of course, interrelations, for policy affects and constrains experiences and the intrinsic characteristics of systems.

Objectives

The Transportation Experience strives for two objectives:

1. It seeks to inform readers of the experiences and logics underlying transportation activities and the ways they are thought about. These are collected in models and techniques that are the essence of the field. As used by the authors, the words “model” and “technique” have quite different meanings. *Model* refers to conceptual schemes used to impute cause and effect; it is a process-oriented word. A *technique* is a device for measuring, optimization, and so on.
2. It seeks to expand the readers’ understandings of the boundaries of current knowledge. It notes that knowledge has accumulated from past experiences. The ways things are thought about and analyzed have been honed on past experiences and that gives us confidence about our approaches. At the same time, the heavy hand of past experiences places boundaries on current knowledge, especially on the ways professionals define problems and think about processes.

Achievement of the first objective takes time, but is quite doable. A first approximation of the content of the field is easy to acquire. Much of what we know about transportation has been reduced to “textbook knowledge,” and there are a number of books to cover elements of the field.
Difficulties arise as we strive to reach beyond textbook-level knowledge. Not many years ago one could command the field by investing time in a library and using a little taste about what is important. Today, however, the literature is much too vast for that approach. There are numerous planning-related journals that would need to be reviewed; for instance, David Banister and Laurie Pickup (1989) remark that they examined some 10,000 references before selecting the 660 used in their book.

The second objective has to do with understanding the boundaries of present knowledge. As stated, knowledge has accumulated from experiences, and we can gain insights about boundaries by understanding past policy formation and planning tasks and how they were managed. The answers to the questions “Why do planners (engineers, policy makers) think the way they do and do what they do?,” “How well does what they do work?,” and “What needs to be done to make what they do work better?” turn in large part on understanding previous experiences.

*The Transportation Experience* strives to enrich the reader’s grasp on all types of transportation. At first glance, this may appear much too vast a task for a single book. Our goal says that we should treat each of the modes—rail, air, highway, pipeline, inland water, transit, maritime, and so on. It says that we should consider transportation at different scales and in different environments—national, regional, state, metropolitan, municipal; urban, rural—as well as in different social and economic situations. It says that we should consider multiple goals and purposes: congestion relief, energy conservation, and provision of a mix of modal services, for example. It says, too, that we should consider analysis of subsystems, such as those posed by railroad fixed facilities, maritime fleet planning, and trucking operations.

Achieving the goal of completeness is not much helped by the literature. At the textbook level, where technical materials and experiences have been digested for classroom presentation and study, books apply mainly to urban transportation planning. The professional literature is also dominated by urban transportation concerns, in recent years emphasizing transit. Some of this material is very demanding from a technical point of view, and its treatment takes time.

The topics we strive to cover are vast, and the reader should be alert to omissions. Some modes, such as short sea (ferry-like) services and pipelines, are hardly mentioned. Many regulatory, pricing, and political theory topics are passed over lightly. However, the signposts in this book should help readers find roads to and through omitted topics.

The imprint of the transportation experience on urban and regional settlement patterns and related topics in another vast topic that we mention only briefly. But those matters are well treated elsewhere. Our extensions to these subjects are limited and signposts will have to do.

**Structure**

A transportation system can be usefully viewed as having a triad structure:

- **Fixed facilities** such as airports and airway navigation facilities or railroads and terminals. On the soft side, there are institutions that match these.
- **Operations** involving many kinds of institutions and protocols, as well as hard technologies, such as traffic lights.
Overview

- There is *equipment* and its production, care, and feeding: locomotives, airplanes, liners, shipping firms, automobile dealers, repair shops, insurance companies, and so on.

Each of these system components has associated institutions, as stated. There are governmental and private institutions, as well as professional associations. Each has specialized financing, management, and fiscal arrangements. To a large extent, policy, planning, and management have their scope determined by their component elements.

Taking railroads as an example, at a first glance there are interacting locomotives and cars (equipment component), routes and yards (fixed facility component), and control systems (operations component). Looking with somewhat wider scope, we see firms producing equipment, constructing and maintaining routes and terminals, and providing services. Expanding still further, we see suppliers to those activities, professional organizations, the Association of American Railroads, federal and state government activities, the operating officers association, and so on.

We may also remark that the triad structure has a *unitary* character, that is, observing its "same everywhere" character. Transportation systems are unitary systems mainly because operations over networks require standardization. There are other reasons that will be noted later. This unitary structure affects behavior. Standards enforce highly predictable behavior, and standards are valued as an instrument of control.

A second feature of behavior is its reactive *disjointness*. Actors in each component of the triad monitor the states of other components and adjust their affairs to fit. For instance, a topic of concern today is how to adjust highway facilities to fit increasing use and consequent congestion. We seek to strengthen pavements to accommodate larger and heavier trucks. The air traffic control system is being improved to accommodate larger aircraft and growing traffic.

The unitary character of transportation together with the disjoint nature of system structure place sharp limits on images of what planning should be and what it can do. Often, planning is component constrained, and its system impact may be limited; it may also be limited because unitary standards limit degrees of freedom. Planning strives to catch up with and adjust to developments elsewhere. Broadly, a system gets started and the predominant hard and soft technologies are frozen. From the point of view of steerability, the die is cast. System development moves along a predetermined path.

Gabriel Bouladon (1967) has provided a notion of inherent service capability and compared service capability to demand, shown in figure 1.2. Bouladon suggests gap filling as a role for planning. This notion has been adopted in Japan (figure 1.3).

In figure 1.2, the left scale is a log scale, and the optimum utilization line indicates how the demand for trips decreases with distance. The x-axis is also a log scale. Plotting the service a mode can provide, one sees some combinations of distances and demand volumes where there are gaps. For instance, the "too far to walk and too close to drive" market is only partially served. Most commuters don't have horses available, and bicycles don't work well for many individuals and in certain climates and terrains. The Segway, for instance, seeks to fill this gap and uses the idea in marketing.1 The "too close to fly, too far to drive" gap is the target for high-speed rail planning.

Figure 1.4 shows a similar idea for freight. The freight scheme doesn't show gaps as the Bouladon scheme does. Gaps are to be imagined in the vicinity of the lines separating zones of modal dominance. Truck trailers on freight cars (TOFC), for example, are carving out mode shares at the truck—rail long-distance interfaces.
Figure 1.2. Transport gaps: density vs. distance. (Source: adapted from Bouladon, 1967.)

Figure 1.3. Adaptation of transport gaps to Japan. (Source: adapted from Nehashi, 1998.)
Overview

We think of the unitary, disjoint, and lack of steerability attributes of systems as dysfunctions. They suggest three roles for planning:

1. Accept the dysfunctions and work within the constraints they set.
2. Seek ways to truly steer systems by working around or breaking the tyranny of the dysfunctions.
3. Identify and fill transportation gaps.

Performance

There is another generic consideration bearing on transportation. It is what we like to refer to as the intrinsic character of transportation systems: how systems behave and how they perform.

Figure 1.5 displays an S-shaped curve, the realization of the railroad system in the United States. Such curves characterize many features of transportation systems and other systems as well. Early on, the planning task was to determine what the rail system should be like. Through much of the history of the rail system, planning tasks had to do with deployment: network arrangements, capacity needs, sequenced deployment, and so on. When deployment approached saturation, the task changed. Nowadays, planning has the task of managing a mature (senile?) system. The point is that there are different planning tasks as a system develops: acts in play, so to speak.

Two words, stable and linear, characterize the process that yielded the realization shown in the figure. The process is stable because observed points fit the development path closely. If for some reason the path diverges as the mileage path did during 1890s when there was little track laid, the path returns to its stable trajectory. It is a linear path: convert the y-axis to logs, and a nearly straight line results.
Figure 1.5 shows one component of one system. The S-shaped temporal realization of behavior applies to other components of the rail system (vehicles and operations) and its performance. (Performance has to do with what a system does that is worthwhile.) In general, S-shaped realizations of behavior are found for all transportation systems.

This introduction is not the place to further explore the implications of system behavior. We shall only note that most of the planning experience has been with stable, linear processes. Yet planning addresses changes, and for change to occur we must create and manage unstable, nonlinear processes. A system is unstable if a small perturbation from its past track sends it off in a changed direction. It is nonlinear if there are branch points or discontinuities.

We now assert that the planning (and control) of nonlinear, unstable processes is today’s central transportation problem. *The Transportation Experience* will discuss that assertion; it will permeate our discussion.

**Conduct**

Transportation policy is an attractive topic for study because of the strong interrelations between policy and the nature of transportation systems. The policy story tells us what transportation is, does, and can or might do.

Policy may be defined as sets of formal and informal rules that control the innovation, construction, operation, financing, service provision, and other attributes of transportation systems. That is a vast subject area. There are policies for the testing of concrete pavements, for land taking, the funding of airports, the domain or scope of agency concerns and powers, controlling the range of products offered by equipment manufacturers, safety inspections, the subsidy of liner operators, and so on. Further, the limits on the subject area are not well defined. For example, policy and planning overlap, for in many ways planning is the application of policy.
This breadth is of concern because transportation professionals are expected to know
the rules that apply to their environments. Knowing requires more than an ability to list
policy rules to which work should adhere and where those rules are to be applied. Even
so, policy courses historically have had a “What is it?” thrust. Business schools offered
policy courses dealing with the regulation (and deregulation) of commercial trans-
portation. Where policy was treated in civil engineering departments, it emphasized
highway funding and construction protocols. The results of such courses are but a
limited snapshot of a descriptive sort.

The Transportation Experience seeks to provide deeper “knowing.” It strives to help
the reader understand how and why policies (rules) are developed and how to assist in
forging policies to improve the functioning of systems.

The earlier discussion of topics to be emphasized indicated one of the ways The
Transportation Experience will seek to manage the vast breadth and strive for depth.
The insights gained will cut through vastness. It will be seen how learning in one situ-
ation is applied to another (policy is a result of experience and exchange), how policies
mirror the intrinsic characteristics of systems, and how policies may be embedded or
shared with governments. For example, transportation systems are networks, and there
are policies, similar across the modes, that result from networking. Network integration
policies are critical in all modes.

On a larger scale, the study of policy says how society has learned to create, deliver,
and operate large, complicated systems that serve specific tasks very well. The insights
extend beyond transportation because there are a number of large, complicated systems
that share the structure of transportation systems. Transportation policy has lessons for
all public facility systems.

In spite of those nice words about the bright side of the study of transportation policy,
there is an overwhelming dark side. As a result of that dark side, some regard policy
work as trivial, foolish, or counterproductive. It is often treated as a second-class subject,
at best.

There are some quite perceptibly troublesome things. It is true that poor analysis gets
published by claiming values for policy. Policy often results in using resources in
unproductive ways. Often policy yields large cross-subsidies, and the ethical and social
values of these are unclear. Policy often yields stasis rather than development.

One summary statement about the dark side compares policy making to sausage
making, an activity that fastidious persons should avoid. Another is that the debate is at
best petty and unseemly squabbles over marginalia. Howard Darling (1980), the dean
of Canadian policy analysts, had this to say:

[The policy debate is] . . . swamped by a flood of ingenious rationalizations equating one’s
self-interest with other people’s responsibilities (p. 186) . . . confusion extends to those
who suppose that some new and elaborate recasting of transportation legislation is going to
work like a tranquilizer (p. 235).

Such statements often apply. Although Darling mainly had railroads in mind, his
remark certainly applies to the debates about urban transportation. In the United States
there is a geographical organization of political power that affects the forging of policy
and the distribution of gains and losses from policy actions. There is the many against
the few consideration in decision making (and its reverse: the well-organized few
against the many). These features of the political scene affect transportation.
Introduction

Transportation systems have complex social and economic interrelations, and individuals and organizations have limited abilities to perceive their structure and performance. The general public’s perceptions stem mainly from subjective user experience; newspaper and TV coverage has scant depth. Policy needs are seen in response to the evil things that happened yesterday, and policy becomes, in Darling’s (1980) words, “a series of ritualistic poses” (p. 5) and “witchcraft” (p. 178). We would not fault the public for wanting corrections for the problems it senses, and that is not the intent of these comments. Rather, it is to point out that professionals too often fail to respond to the signals the public sends. The public identifies an undesirable symptom (or states a goal), yet the professional is unable to provide an appropriate diagnosis and suggest a cure. Professionals lack effectiveness when they fail to perceive the nature of system processes and the relation of policy to those processes. There are lots of excuses for this.

One excuse is the disjoint structure of transportation systems—they divide into fixed facilities, equipment, and operations. The typical professional is a member of a component, and has limited system understanding. Cognition, need to know, and loyalty are component bound. There are highway experts, vehicle experts, traffic experts, transit experts, airport experts, logistics experts, and others, but few transportation experts. Division of labor is a virtue, of course, and not everyone can or should hold deep knowledge across transportation. Even so, all should know enough to contribute to development or at least know enough to do no harm. There are also specialists from nontransportation fields who wish to have their say on policy. Regardless of the elegance of the home discipline, such experts have limited cognition.

Another excuse is the large time-span that characterizes the behavior of systems. Processes work out over decades, and the professional is informed by only that part of the process experienced. Altshuler (1965) remarked that highway and transit answers are preselected solutions to the urban transportation problem, and that is a comment on the experiences of those offering solutions. So even the professional engages in petty squabbles over marginalia. Marginal because the debate is over whether to do a bit more or less of what went before, and petty because of narrow scope and thus consequence. Darling also used the word “unseemly.” It is simply unseemly for the professional to debate from limited knowledge.

Reference in the paragraphs above has been to excuses. There are no reasons why the transportationist cannot command policy, enact plans, and deploy systems. All that is needed is to broaden our cognition in a full, methodical way, and that is the essence of The Transportation Experience.